IMPROVING AIS DATA RELIABILITY

Svetoslav Sotirov
Chavdar Alexandrov

Nikola Vaptsarov Naval Academy, 9026 Varna, Bulgaria
e-mail: svetoslav_sotirov@abv.bg, ch.alexandrov@nvna.eu

Abstract: In 2000, IMO adopted a new requirement (as part of a revised Chapter V of SOLAS Convention) for all ships to carry Automatic Identification System Transponders (AIS Transponders) capable of automatically providing information about the vessel to other vessels and to coastal authorities (IMO 2017). AIS is a system of worldwide importance which strives to achieve the following goals:

- **vessel tracking** - automatically exchange information about the ship's identity, type, position, course, speed and navigational status with appropriately equipped shore stations and other ships;
- **maritime security** by means of identifying threats to a country's sovereign borders;
- **collision avoidance** by plotting the course and speed of vessels within range;
- **efficiency** – monitoring port traffic allows for efficient transfer of vessels between harbors;
- **improved communication** – direct ship to ship communication;
- **information gathering** – monitoring hydrological and metrological factors, etc. (All About AIS, 2012).

Accidents caused by the navigators' trust in the AIS are possible, however, if vessels are not equipped with known and trustworthy sensors. These "AIS assisted accidents" might take place as has previously been the case with RADAR, ARPA and GPS assisted accidents. The navigators' assessment of collision risk depends upon their knowledge about own ship's motion and other ships' motion (Ramsvik 2001).

Nowadays most navigators are not familiar with the AIS technology and may use the AIS information uncritically and trust the AIS information in disfavor of the RADAR / ARPA information.

In this paper a huge amount of AIS data has been analyzed and a serious number of errors have been detected. The conclusion is that a great number of vessels transmit incorrect AIS data. The reason for these incorrect data is to be found in the actions of both the technicians installing the device and the crew members responsible for entering the data in the system. Examples of wrongly entered data include: Call Sign, AIS Type, Antenna Position, Draught, Destination and ETA, Navigational Status, etc.

Solutions to this problem are the more elaborative training of the technicians and navigators operating with the system as well as the more rigorous control measures on the part of the responsible authorities.

Keywords: AIS, Safety of Navigation, Human Factors, Reliability, Errors

1. Introduction

A number of electronic systems have been developed for the purpose of navigation security and safety enhancement such as, for example, the RADAR and the Long-Range Identification and Tracking system. One of those systems is the Automatic Identification System (AIS) broadcasting messages from a vessel or a coastal base station to all surrounding vessels and coastal base stations within the radio horizon range.

In 2000, IMO adopted a new requirement (as part of a revised Chapter V of SOLAS Convention) for all ships to carry Automatic Identification System Transponders (AIS Transponders) capable of automatically providing information about the vessel to other vessels and to coastal authorities (IMO 2017). AIS is a system of worldwide importance which strives to achieve the following goals:

- **vessel tracking** - automatically exchange information about the ship's identity, type, position, course, speed and navigational status with appropriately equipped shore stations and other ships;
- **maritime security** by means of identifying threats to a country's sovereign borders;
- **collision avoidance** by plotting the course and speed of vessels within range;
- **efficiency** – monitoring port traffic allows for efficient transfer of vessels between harbors;
- **improved communication** – direct ship to ship communication;

- **information gathering** – monitoring hydrological and metrological factors, etc. (All About AIS, 2012)

Accidents caused by the navigators' trust in the AIS are possible, however, if vessels are not equipped with known and trustworthy sensors. These "AIS assisted accidents" might take place as has previously been the case with RADAR, ARPA and GPS assisted accidents. The navigators' assessment of collision risk depends upon their knowledge about own ship's motion and other ships' motion (Ramsvik 2001, Tsvetkov 2013).

Nowadays most navigators are not familiar with the AIS technology and may use the AIS information uncritically and trust the AIS information in disfavor of the RADAR / ARPA information.

2. Source of Analyzed AIS Data

As part of my Ph.D. research on the transportation and trade with petroleum products in the Mediterranean and Black Seas region I have worked with a huge amount of AIS data obtained from VT Explorer, a service provided by the Bulgarian software company Astra Paging Ltd. The analyzed data is related to the daily traffic of tanker vessels in the area of the Mediterranean and Black Seas for the period from 1st January 2013 till 31st December 2015. Throughout my work I have observed a serious number of errors in the AIS data and this has motivated me to research the issue more thoroughly.

3. AIS Data Processing

The data used for the current analysis have been segregated into three parts for each year. Each part consists of the following information: Date and Time, MMSI, Position, Speed Over Ground, Course Over Ground, IMO Number, Ship's Name, Call Sign, Hazardous Cargo Type, Antenna Position, Ship's Draught, Destination and ETA. Criteria for filtering have been applied for the categories Call Sign, Hazardous Cargo Type, Antenna Position, Ship's Draught and Destination. As incorrect data have been considered untypical signs used for the Call Sign, Hazardous Cargo Type provided for vessels other than tankers, untypical antenna positions, draught in discrepancy with the conventions and missing or unreliable description of the destination. The number of the vessels received after the filtration of each group has been presented as a part of all studied vessels.

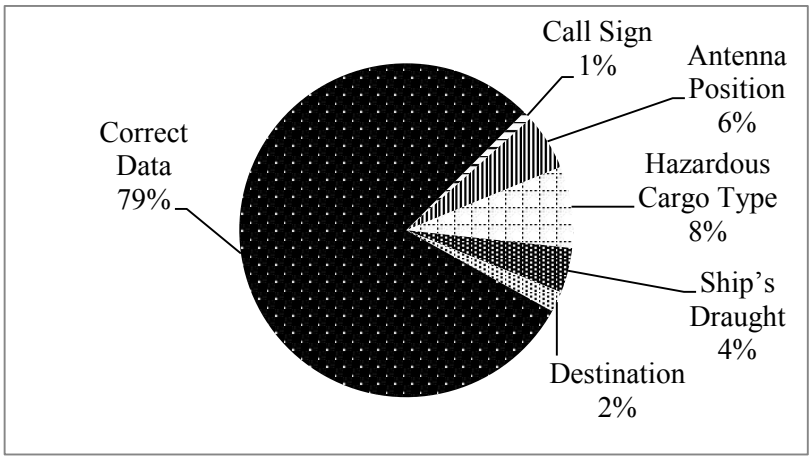

Figure 1: Transmitted incorrect AIS Data from tanker vessels for 2013.

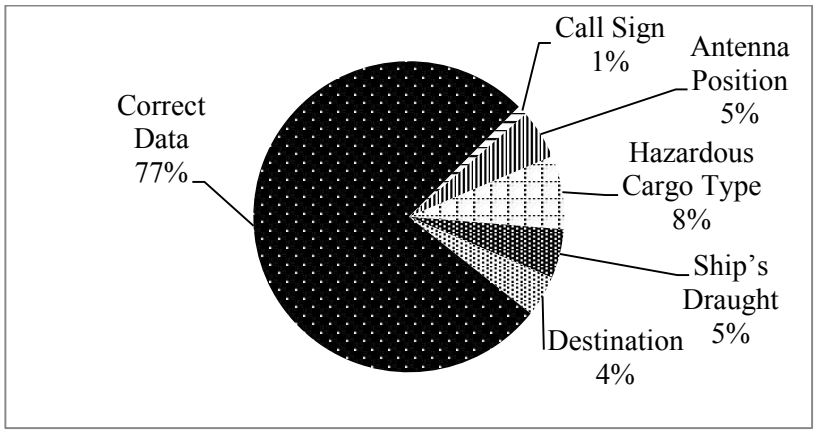

Figure 2: Transmitted incorrect AIS Data from tanker vessels for 2014.

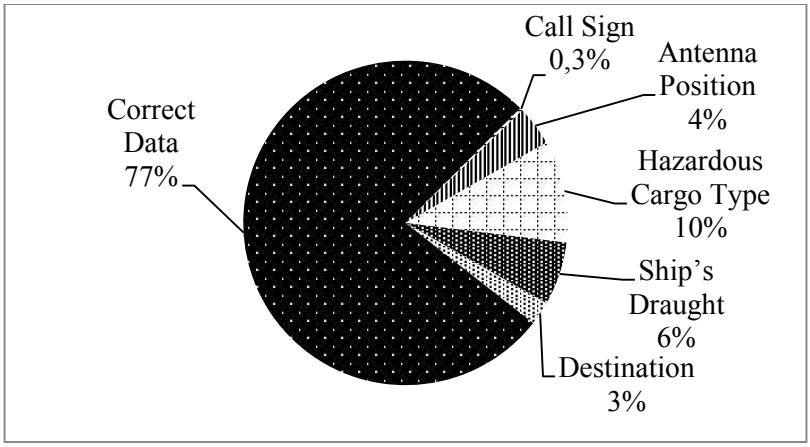

Figure 3: Transmitted incorrect AIS Data from tanker vessels for 2015.

Comparison of the incorrect data based on the different type of the AIS data (i.e. static vs. voyage related data) has been made for the same period (Figure 4 below). Part of the static data

are the Call Sign and Antenna Position and these are the data entered by a certified technician during the AIS device installation whereas the voyage related data entailing Hazardous Cargo Type, Ship's Draught and Destination are provided by the vessels' navigational officers.

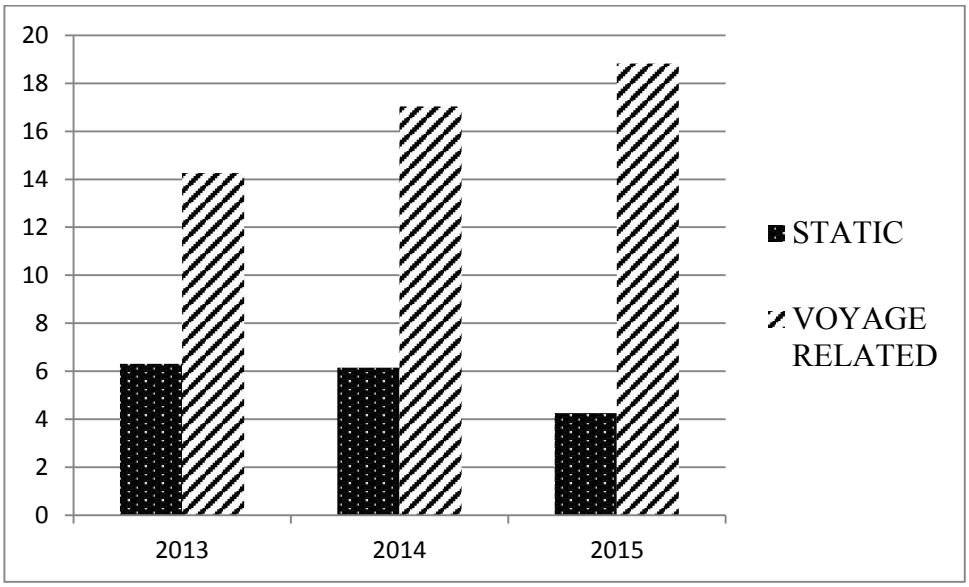

Figure 4: Static vs. Voyage Related Data

4. Data Analysis

The analysis of the results depicted in figures 1, 2 and 3 shows that there is a steady percentage of the transmitted incorrect data from the tanker vessels and more precisely, 21% of incorrect data in year 2013, 23% in 2014 and 23% in 2015. The majority of the errors fall into the message of incorrectly provided Hazardous Cargo Type, followed by the messages Ship's Draught, Antenna Position, Destination and the least number of errors is related to the Call Sign message.

Figure 4 above shows that the errors in voyage related data prevail significantly over the errors in static data which means that more incorrect data are provided by the navigational officers onboard the vessels rather than by the technical experts installing and supporting the system. Also for the reviewed three-year period (2013 – 2015) the following trend is observed: the percentage of errors in voyage related data (especially in the categories of Hazardous Cargo Type and Ship's Draught) increases.

Considering the high percentage of incorrect AIS data (based on the analysis above around one-fifth of the transmitted AIS data include errors) the conclusion can be made that the AIS data is

not quite reliable. As these data are used worldwide for a number of reasons, it is of significant importance to improve their reliability.

5. Reliability of AIS Data

Some recent studies distinguish among three major cases of bad AIS data quality, and more precisely: errors (when false data is non-deliberately broadcasted), falsifications (when false data is deliberately broadcasted) and spoofing (when data is created or modified and broadcasted by an outsider) (Ray, C., Iphar, C., Napoli, A., Gallen, R. & Bouju, A. 2015 pp. 2-6).

As the analysis above shows, as well as other studies worldwide have proven, the AIS Data is rather unreliable. But what might be the reasons for that significant percentage of errors in the AIS Data?

Data contained in AIS messages can be erroneous, falsified or spoofed for several reasons such as:

- lack of strong verification of the transmission,
- using a non-secured channel when doing the transmission,
- lack of knowledge on the part of the crew regarding some pieces of information or
- intentional hiding of information by the crew from other people's knowledge.

The factors above tend to modify and handicap the understanding of the maritime traffic (Iphar, C., Napoli, A., Ray, C., Alincourt, E. & Brosset, D., 2017. pp. 607).

6. Solutions to the Problem

Since the development of AIS in the year 2000, a training on working with AIS has been introduced in the formal educational program of all navigation officers. Respectively, all maritime officers who had graduated before the year 2000 (i.e. the larger number of officers working with AIS) have not undergone such a training on working with the system (IMO Model Course 1.34). It is of utmost importance for such an additional training different maritime training organizations worldwide and for all navigational officers to attend that training and get certified on being able to work with AIS. Such a certificate should be required from all users of AIS as a prerequisite for their signing a work contract and boarding a vessel. Regular trainings for updating their knowledge and demonstration of competency in entering and checking ship's

AIS data should be organized as well for the technical experts installing and supporting the system as they are responsible for a certain amount of the errors in the transferred AIS data.
Apart from improvements to the AIS training programs, other solutions to the issue at hand and means for minimizing data errors that now pose challenges in the reliability and ease of use of AIS data can be:

- advancing the state of AIS technology,
- integration of AIS into ship and shore communication systems as well as
- feedback to mariners (Schwehr, K., McGillivary, P., 2007, pp.8).

7. Conclusion

In this paper a huge amount of AIS data have been analyzed and a serious number of errors have been detected. The conclusion is that a great number of vessels transmit incorrect AIS data. The reason for these incorrect data is to be found in the actions of both the technicians installing the device and the crew members responsible for entering the data in the system.
Solutions to this problem are the more elaborate training of the technicians and navigators operating with the system as well as the more rigorous control measures on the part of the responsible authorities.

References:

INTERNATIONAL MARITIME ORGANIZATION (IMO), 2017. *Regulations for carriage of AIS.* [online]. [viewed 25/01/2017]. Available from: http://www.imo.org/en/OurWork/safety/navigation/pages/ais.aspx

ALL ABOUT AIS, 2012. *AIS applications*. [online]. [viewed 26/01/2017]. Available from: http://www.allaboutais.com/index.php/en/aisbasics1/ais-applications

RAMSVIK, H. 2001. AIS as a tool for Safety of Navigation and Security - Improvement or not?. [online]. [viewed 25/01/2017]. *Alert!*. Available from: http://www.he-alert.org/filemanager/root/site_assets/standalone_articles_not_linked_to_a_bulletin/HE00180.pdf

RAY, C., IPHAR, C., NAPOLI, A., GALLEN, R. & BOUJU, A. , 2015. Detection of AIS Spoong and Resulting Risks. MTS/IEEE OCEANS'15, May 2015, Genes, Italy. In: *Sciences de l'Homme et Société,* pp. 2-6. [online]. [viewed 25/01/2017]. Available from:

https://hal-mines-paristech.archives-ouvertes.fr/hal-01166151/document
IPHAR, C., NAPOLI, A., RAY, C., ALINCOURT, E. & BROSSET, D., 2017. Risk analysis of falsified automatic identification system for the improvement of maritime traffic safety. In: WALLS, L., REVIE, M., BEDFORD, T., eds. *Risk, Reliability and Safety: Innovating Theory and Practice*. London: CRC Press, pp.607.
SCHWEHR, K., MCGILLIVARY, P., 2007. Marine Ship Automatic Identification System (AIS) for Enhanced Coastal Security Capabilities: An Oil Spill Tracking Application. In*: Oceans 2007. Aberdeen, 18 Jun - 21 Jun 2007.* pp. 8.
TSVETKOV M., Software module for GNSS Navstar radioephemeris processing, *Journal of Marine Technology and Environment*, ISSN 1844 –6116, Year V, 3/2013;